

CLAIMS

1. Noninvasive method for measuring blood components, wherein, with the use of spectrophotometry, light from at least one light source is generated and passed through a tissue located at an application site to at least one photoelectric transducer, and wherein at least one measuring signal of the photoelectric transducer is conducted to an evaluation unit, characterized by the fact that light signals of a first wavelength are generated at two successive times T_1 and T_2 , that light signals of a second wavelength are generated at two successive times T_3 and T_4 , that light signals of a third wavelength are generated at two successive times T_5 and T_6 , and that this procedure is continued for n pairs of times T_n and T_{n+1} at n wavelengths. The times $T_n \dots T_{n+1}$ have a well-defined relationship with respect to time. Time differences between individual times can be small. The evaluation unit considers the incoming signals from the photoelectric transducer for all n wavelengths according to a predetermined computational model to determine the concentration of a blood component.

2. Method in accordance with Claim 1, characterized by the fact that the evaluation unit considers a quotient of the measuring signals.

3. Method in accordance with Claim 1 or Claim 2, characterized by the fact that the logarithms of the measured values are taken.

4. Method in accordance with any of Claims 1 to 3, characterized by the fact that a quotient of the logarithmized measured values is considered.

5. Method in accordance with any of Claims 1 to 4, characterized by the fact that the light is generated by light-emitting diodes.

6. Method in accordance with any of Claims 1 to 5, characterized by the fact that the incoming signal is received by a photodiode.

7. Method in accordance with any of Claims 1 to 6, characterized by the fact that at least three different light sources are used.

8. Method in accordance with any of Claims 1 to 7, characterized by the fact that the total hemoglobin concentration is determined.

9. Method in accordance with any of Claims 1 to 7, characterized by the fact that the concentration of components that are not associated with hemoglobin is determined.

10. Method in accordance with any of Claims 1 to 7, characterized by the fact that the concentration of bilirubin is determined.

11. Method in accordance with any of Claims 1 to 7, characterized by the fact that the concentration of myoglobin is determined.

12. Method in accordance with any of Claims 1 to 7, characterized by the fact that the concentration of iatrogenically administered dyes is determined.

13. Device for measuring blood components, which has at least one light source, at least one photoelectric transducer, and at least one evaluation unit connected with the photoelectric transducer, characterized by the fact that at least three light sources (1, 2, 3) are used, which generate wavelengths that are different from one another, and that the evaluation unit (6) has an arithmetic unit (7) both for taking logarithms and for performing divisions, multiplications, additions, and subtractions.

14. Device in accordance with Claim 13, characterized by the fact that at least one of the light sources (1, 2, 3) is realized as a light-emitting diode.

15. Device in accordance with Claim 13 or Claim 14, characterized by the fact that the photoelectric transducer is realized as a photodiode.

16. Device in accordance with any of Claims 13 to 15, characterized by the fact that each of the light sources (1, 2, 3) generates light in a narrowly defined frequency band.

17. Device in accordance with any of Claims 13 to 16, characterized by the fact that one of the light sources (1, 2, 3) generates light with a wavelength of about 660 μm .

18. Device in accordance with any of Claims 13 to 16, characterized by the fact that one of the light sources (1, 2, 3) generates light with a wavelength of about 805 μm .

19. Device in accordance with any of Claims 13 to 16, characterized by the fact that one of the light sources (1, 2, 3) generates light with a wavelength of about 950 μm .

Figure 1.

KEY:

Emissionssteuerung = emission control

n - Emittoren = n emitters

m - Detektoren = m photoelectric transducers

Signalverarbeitung = signal processing

Figure 2.

KEY:

Konstantgewebe = constant tissue

Pulsatiler (arterieller) Blutraum = pulsatile (arterial) blood

|compartment

| Figure 4.

KEY:

Bestimmung C_{Hb} = determination of C_{Hb}

Figure 5.

KEY:

Bestimmung von C_x = determination of C_x

Ref.-Methode = reference method

Figure 6. Spectral absorption of blood for $\text{saO}_2 \sim 98$ [%]; Hct = 44 [%]; pH = 7.4; $\pi = 0.3$ [Osm]; $d = 67$ [μm]. Cf. H_2O absorption. Source: Roggan, A.: Dosimetry of Thermal Laser Applications in Medicine; ecomed 1997

KEY:

Blut = blood

Wasserabsorption = water absorption

Wellenlänge = wavelength

Figure 7. Spectral absorption of Hb derivatives: functional and dysfunctional Hb derivatives. Source: Holbek, C.: New Developments in the Measurement of Co-Oximetry. Anesth Analg; 94: pp. 89-92.

Figure 8. Spectral absorption of clinical marker substance Evans blue. Aqueous solution $C_{\text{EB}} = 70$ [$\mu\text{moles/L}$]. Source: Roggan, A.: Dosimetry of Thermal Laser Applications in Medicine; ecomed 1997

KEY:

Wellenlänge = wavelength

Figure 9. $spO_2 = f(\omega)$ Lambert-Beer and additional non-Hb
pulsatile absorption. $WL1 = 660$ [nm] $WL2 = 905$ [nm] $c_x / CHb =$
 $0.25 \times (660, 905) = 3.$